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FEET.

January 4, 1899. Telegram announced (on pilot's range). 13.3

February 11, 1899. Capt. Welker wired the Coast Survey
office..... 15.0

ECONOMY AND DEPTHS UNPRECEDENTED.—So that in two years there was a gain of eight feet produced by a half-finished structure in the face of serious obstructions at a cost of less than \$30,000 per foot depth as compared with from \$200,000 to nearly \$900,000 at other places by the usual twin jetty system. It may therefore be safely stated, even without awaiting the completion of the breakwater and the removal of the obstructing jetty, that as our respected Vice-President, Mr. Coleman Sellers, remarked only last evening in referring to the progress of the Mechanic Arts: "Two blades of grass have been made to grow where one grew before." In fact the adage may be carried further, since in this case the half of a blade (jetty) has done what two complete blades (jetties) have never done before in the same time, without dredging, and the American Philosophical Society has evidently not made a mistake of judgment in awarding its highly prized Magellanic premium and medal for this "invention and discovery."

GENEALOGICAL TREES OF BUTTERFLIES.

BY A. RADCLIFFE GROTE, A.M.

(Read October 6, 1899.)

Previous to 1897 the butterflies were generally regarded as monophyletic, springing from a single stem, the family branches being variously arranged by different authors. In classification they were kept together as "Rhopalocera;" and the only exception to this course was the more recently attempted exclusion of the Skippers, the family Hesperiadæ, under an analogous title, equally derived from the Greek, and having reference to the structure of the horns or antennæ. It must be admitted that the reasons given for this were inconclusive, where they were not wholly absent.

From studies of the neururation I was able to announce (February,

1897) the diphyletism of the diurnals, separating for the first time the Papilionides as a distinct phyletic line from the rest of the butterflies, and keeping these latter together under the title of Hesperiates. It is the Hesperiates alone whose ancestry can be sought for in the Noctuid branch of Dyar's Bombycides (Agrotides), since to this presumptive lineage the Papilionides are apparently alien. For the general pattern of the veining of the Lycæni-Hesperiadæ is repeated in the Agaristid branch of the Bombycides, equally without any indication of affinity with the Papilionid type. With regard to classification and linear succession, it may be said that in the main points I follow Fabricius, in 1787, but it must be said that I give adequate reasons for so doing which were previously wanting.

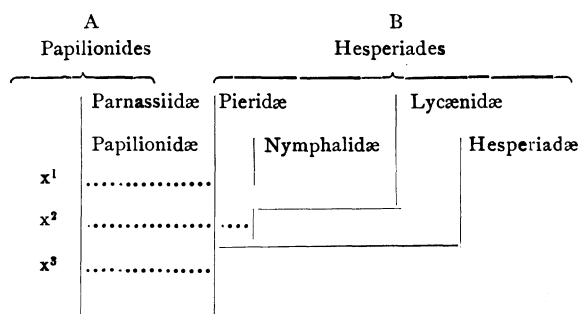
At the risk of appearing self-assertive, I endeavor to give clearly the original points brought forward by myself in various papers, and to the above statements there must be added, that I have tried to prove that the Blues and the Skippers are directly related, however distant the time may be assumed at which the divergence took place. The interpolation, therefore, between these two groups, of the group of the Swallowtails, by Scudder, Comstock and other observers, would be wholly inadmissible. I show that the points of similarity in structure between the Swallowtails and Skippers, brought forward by Mr. Scudder in 1877, are due to convergence, to that parallelism in development, announced by Milne-Edwards, of which Mr. Scudder appears to take no note, and for which he makes no allowance. Through studies of the Charaxinæ it becomes clear that the hesperid wing, with separated veins, underlies the wings of the group, while a normal evolutionary change in the specialization of the Radius develops in succession the wing of the Blues out of that of the Skippers.

The family Hesperiadæ are then a survival of an ancestral stage in the evolution of the other groups of the Hesperiates, *i. e.*, the Pieridæ, or Whites, the Nymphalids, or brush-footed butterflies, the Lycænids, or Blues. I show, from the fact that a diminution of the internal veins of the hind wings accompanies specialization in other groups of the Lepidoptera (*i. e.*, Saturniades, Tineides), that the Papilionides, or Swallowtails, cannot represent an ancestral phase of any of the other families of the diurnals, because in this respect they are the more advanced group. The assumed generalization of the Papilionides, which has led to the view that they are

lower than the other butterflies, would be a mistaken assumption. The opposite view, that the Hesperiaes represent ancestral forms of the Papilionides, would be the more tenable, were it not contradicted by the fact that the Papilionides possess an exclusive character in the short, downwardly curved anal vein of the fore wings. The diphyletism of the two groups becomes thus apparent and prevents further comparison. The Papilionides and Hesperiaes are parallel developments and neither represents an ancestral stage of the other.

In a review of the genealogical trees of the butterflies hitherto published, it will again make the subject clearer if we commence with the diphyletic tree, first published by me in 1897. I choose here the elementary first sketch, already printed in the PROCEEDINGS OF THE AMERICAN PHILOSOPHICAL SOCIETY for January, 1899, giving dotted lines to show the different points at which it has been presumed that the Papilionid line may have intersected with the Hesperid. In the trees published by me in the *Butterflies of Hildesheim* and in *Natural Science*, I endeavored to intercalate the minor divisions upon this basis. The three culminating family groups, the Parnassiidae, Pieridae and Lycænidæ, have, in certain forms, the Radius of the fore wings specialized by the reduction of the branches to four, and sometimes even three in number. In the three lower groups the Radius always remains in a generalized, five-branched condition. Most of the six family groups of butterflies retained have been elsewhere subdivided into families; but, for the sake of simplicity, the names are here used in their older collective sense.

FIG. 1. *Diphyletic genealogical tree of the Butterflies, Grote, 1897.*



EXPLANATION.

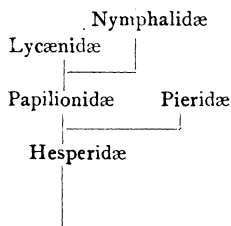
x¹. Dotted line of connection proposed in consequence of analogies of the Papilionides with the brush-footed butterflies. This line is apparently favored by Chapman, 1895, Packard and Quail.

x². Dotted line of interconnection indicating that the Papilionides represent an ancestral form of the other butterflies, excluding the Skippers. This line is favored by Scudder, Comstock and others, who place the Papilionides between the Lycænidae and Hesperiadæ, just above the latter.

x³. Dotted line of interconnection indicating that the Papilionides represent an ancestral form of *all* the diurnals and that these latter would be monophyletic. I reject *all* the dotted lines, considering the butterflies as diphyletic. The two separated stems, and the arrangement of the collective groups, represent the conclusions to which I have arrived.

I shall now briefly discuss the monophyletic trees published by authors and reproduce two of them. The monophyletic designs published by Scudder (1877) and Reuter (1896) do not differ in principle. In both the brush-footed butterflies are placed "at the head," and the view is expressed that the Papilionides are degraded forms. In addition, Reuter conceives that the Papilionides embrace also the Pieridæ, an old opinion based mainly on coincidence of color between the Parnassians and the Whites and a similarity in pupal suspension. I have endeavored in my writings to expose its fallacy. All methods of pupal suspension in the butterflies are paralleled in other Lepidoptera. The drawings published by Scudder and Reuter are too fanciful or complex to allow of reproduction here.

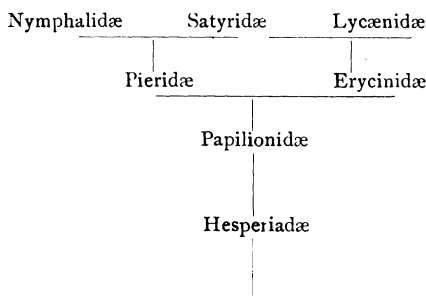
FIG. 2. *Monophyletic tree of the Butterflies, Packard, 1895.*



In this genealogical tree the collective family groups are reduced to five, the Parnassiidæ being fused with the Papilionidæ. A comparison of this tree with Fig. 1 will show that the entire butterflies are intercalated between the Lycænids and Skippers. The ancestors of the Skippers are first imagined to have thrown off the

Pieridæ, these the Swallowtails, these the Nymphalids and again the Blues. The dislocation of the Blues and Skippers is entire and the positions are so reversed that a criticism here would take up too much space. This criticism will, moreover, become apparent upon a comparison with what I have written in these pages and elsewhere. It will be better to pass on to the latest tree published of which I have any knowledge.

FIG. 3. *Monophyletic tree of the Butterflies, Hampson, 1898.*



It is to be presumed that Mr. Meyrick agrees with this classification. There is no entire tree of the butterflies in the *Handbook*, 1895, but the classification agrees with the above, while there are a number of diagrams of the generic branchlets. A study of these show that Mr. Meyrick has not read the meaning of the changes in position of the veins as made out by Comstock and myself. It is characteristic of the genealogies of Meyrick and Hampson, that no reasons for the position of the groups are given in the accompanying text. They cannot thus be subjected to a proper scrutiny, and are, to a great extent, enigmatical. In the above tree the Hesperiadæ, with two internal veins on the hind wings, are placed at the base of the series, in the position of ancestors of the Papilionides, which have only one. This, of itself, would not be incredible. But we are further asked to believe that the Papilionides, with one internal vein, have then given birth to a variety of divergent forms having again two internal veins on the hind wings. This is quite incredible. It may be said that analogous contradictions occur in such of Mr. Meyrick's genealogies as I have carefully examined. It is understood that Mr. Meyrick has paid great attention to the veining of the wings, but in his resultant systems the character is apparently not regarded as crucial.

The object of this communication is attained by this brief review of the genealogical trees of the butterflies in literature. The anomalous position of the Papilionides, assigned to them by Bates, Scudder and the Scandinavian school of writers, has been the principal cause of confusion. In addition, the methods of general zoölogy have been neglected, and this neglect has led to a system of false reasoning, by which the misplacement of the Papilionides has been propped up. To all this has often been added a lack of any serious study of the neururation. The fact that no monophyletic tree of the butterflies will work satisfactorily and stand criticism may be thus explained.

The termination of Superfamily names in *ides* was proposed by F. J. Buckell and adopted by myself in 1895. The names Hesperif[a]des and Papilionides are used by Dr. Chapman as early as April, 1895, but the former name is used for a group containing only the Skippers, while under the latter title all the rest of the diurnals are included. Thus Dr. Chapman's Hesperides equal the Grypocera of continental writers, and his Papilionides their Rhopalocera. This is also the same as the classification by Prof. Comstock in 1893, who gives the English names of Skippers and Butterflies to the two groups, and ventures to say that "if we remove the Hesperidæ (Comstock's Skippers) from the division of the order, as indicated above, the Butterflies form a well-defined group." The classification, however, proposed in my writings is here opposed to both that of Dr. Chapman and of Prof. Comstock, as well as to that of all other authors known to me. The diphyletism of the diurnals is mooted by no other writer and the idea is original with myself.

The Papilionides appear to form a closed group. The Hesperriades appear to be an open group, open to the moths. The Nymphalids, or brush-footed butterflies, form several subparallel converging minor groups and seem properly regarded as an offshoot (monophyletic) from the main stem of the six-footed Hesperriades, which latter culminates in the Pieridæ. The parallelism between Leucophasia and Heliconius supports this view. The Whites show a specialization of the Radius, which the Nymphalids do not, while retaining a more generalized stage of suspension of the chrysalis. The fastening of the latter by the tail alone is copied exceptionally in other groups of the Lepidoptera. Here we again have an inequality of specialization in the secondary (generic) characters of the different stages, an observation made by me originally in 1876,

and the correctness of which receives constantly fresh proof as the results of closer studies are published.

When Comstock uses the word "butterfly," he means all the diurnals except the Skippers, the family *Hesperiadæ*. Thus he connects the Papilionides with the other diurnals, including the Blues, and merely regards them as thrown off at an early period. The Papilionides are thus placed at the base of his "butterfly" system, and the Lycænids and Hesperids are divorced, as in Mr. Scudder's arrangement. My course is the very opposite of this. I unite the Skippers with the Blues and connect both with the Nymphalids and Whites (the affinity of which two groups is pointed out by Chapman) under the name *Hesperiades*, and I show that this distinct stem of the Lepidoptera is open to the moths. I then separate the Papilionides as a closed group, having great analogy but no affinity with the rest of the diurnals. The Skippers (*Hesperiadæ*) are really what they appear to be on the surface, an intermediate type between the Lycænids and the moths, assisting in keeping the phylogenetic line open in that direction. But they represent an old and now specialized type, and their proper characters have been made of undue importance by anxious classificators, who have then called them by hard and peculiar names. I try to show that the Skippers are an offshoot of the same main stem which gives us the brush-footed butterflies and the Pierids, from which groups they are not excluded by any character of primary value.

The reversal of the generic arrangement *within* the group of Papilionides is based on neurational features, which prove to me that the Parnassians are more specialized and younger forms. A mere general survey of the group seems to show that this view is reasonable. It must be admitted that *Ornithoptera* is an unusual and original-looking type, compared with the bulk of the diurnals, and one still rich in species in the Australian area. It seems incredible that such a local type should be the offshoot of widely disseminated and more specialized forms of *Papilio*, to say nothing of the Parnassians. On the other hand, it appears not unreasonable to assume that *Ornithoptera*-like butterflies should have thrown off the forms of *Papilio*, many of which retain ornithopteran traits, and to believe that, through dispersal, the suffering of geographic and geologic (climatic) change, the Parnassian types should at length appear. So like the Pierids do the associating Parnassians become, that Mr. Reuter welds them with a nomenclatorial clamp, and Dr. Spuler

draws us a radiating figure, from which they equally project (*Zur Stammgeschichte der Papilioniden*, p. 492). Such progeny, so dissimilar in essentials, cannot have had a common womb. But when we examine the pale Parnassian from northern meadows, and the black and gold Ornithopteron from openings in the tropical forest, then the short anal vein on their fore wings reveals in both cases the blood of the Papilionides, the proof of common descent and of a separate origin from the Pierids and the rest of the butterflies. It is Dr. Spuler (*l. c.*) who derives *Ornithoptera* from Papiliolike forms, so that I am totally at variance with this author in my views as to the classification and phylogeny of the Papilionides. While Dr. Spuler regards *Ornithoptera* as an end form, terminating a Papilionid branchlet, I consider it to represent an initial type coming nearer to the primitive form of the diurnal Papilionides.

I have been thus explicit in order to give clearly the radical points of distinction between the classification of the diurnals by any other author and my own.

Stated Meeting, October 20, 1899.

Vice-President SELLERS in the Chair.

Present, 22 members.

Newly elected members, Mr. Stuart Wood, Dr. Arthur V. Meigs and Prof. Remington, were presented to the Chair and took their seats in the Society.

The decease of the following members was announced :

Prof. Edward Orton, of Columbus, O., October 17, 1899, and Prof. Don Mariano Barcena, of the City of Mexico.

Mr. Henry Carey Baird read an obituary notice of the late Col. Alexander Biddle.

Proceedings of Officers and Council were submitted.

Pending nominations for membership having been read, the Society proceeded to an election.

The Curators presented the completed bound volumes of the Curators' Record of Donations, with Index; also, the bound volume of the Curators' Catalogue of Portraits and Busts.

The Tellers reported the election of the following gentlemen as members of the Society:

Prof. William Morris Davis, of Cambridge, Mass.